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this place from June 6 to July 16, inclusive. These cases were reported by this office to the Bureau as they occurred, together with all of the particulars obtainable at the time.

The board of health has tried to trace the origin and course of the infection and the inclosed report shows the result of their work, and also the small amount of information they were able to obtain from these people, who resent being questioned on health matters and who give misleading answers if they give any at all. The group of cases, 7 in all, from May 31 to July 17, inclusive, is recorded on a city map, and these foci will be carefully watched for a further recrudescence of plague when the rainy season begins.

For the past sixty days there has been very little rain, and a correspondingly large percentage of sunshine. The exact bearing these conditions have had on the cessation of the disease is not known, but in any event the advent of the rainy season will enable us to draw deductions of great interest and value.

Respectfully,

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Chief Quarantine Officer, Hawaii.

The SURGEON-GENERAL,  
U. S. Marine-Hospital Service.

*Bacteriology of bubonic plague in Honolulu.*

HONOLULU, H. I., June 30, 1901.

SIR: By direction of the board of health, through its executive officer, the following is submitted as a report upon the bacteriological investigations in connection with 4 recent cases of bubonic plague occurring in Honolulu:

It is an encouraging feature that no existing causative relation has been discovered between these cases and the single reported case of March 29, a fact which commends the thoroughness of the disinfecting and other prophylactic measures then employed. While it is impossible to state whether the recent cases were due to a fresh importation of the infection from the Orient, or simply a slight recrudescence of the local epidemic of 1900, the probabilities, judging from the experiences of other infected cities, point to the latter.

Through whatever avenue the disease gains access to a community, its specific cause, since its discovery in 1894, has been many times scientifically demonstrated to be the bacillus pestis bubonica, and only upon the recognition of the presence of this bacterium at the present time, the world over, is an absolute diagnosis made. The past few years have seen a vast amount of study and research expended in this direction, as demanded by its importance; since upon its advent in a community, the suspicions roused by the clinical aspects of the case demand, with the greatest practicable expedition, their confirmation or denial. Owing to the momentous problems involved concerning not only the saving of human lives, but the commercial, industrial, and social well-being of the community at large, the bacteriologist has had put upon him heavy responsibilities, which, in turn, have stimulated him to his best efforts, so that, to-day, the literature of the subject is no longer meager; and constantly improving methods of technique are tending more and more to render his work invaluable.

In our series of 4 cases, opportunity was afforded the department for the observation of 2 of the patients during one and two days, respec-

tively, before death, whereby the clinical features could be carefully studied and noted. In one of these two cases, I had an opportunity of obtaining by aspiration, serum from a bubo direct, by which a positive diagnosis was established some twenty-eight hours before death. I have been highly gratified by the fact that in each of the 4 cases, my observations have entirely confirmed the most recently published researches in other infected cities, notably Hongkong, Sydney, and San Francisco.

Considerable misapprehension evidently exists in the mind of the medical profession regarding the "bipolar staining" which has come to be a sort of universal catchword in discussing the characteristics of the bacillus of plague. I find that it is quite generally understood that the tingibility of the individual element is confined exclusively to the two ends, and that a bacillus not showing this peculiarity is regarded with doubt and suspicion. This is a mistake. In the hanging drop unstained preparation the protoplasm of the element is seen to be densely aggregated at each end and gradually thinned, so to speak, toward the center of the rod, at which point it seems comparatively fluid or watery. The absorption of the stain being directly as the density of the cellular content, its appearance would naturally justify the statements of the earlier observers of three or four years ago, that "the bacillus has usually the appearance of a diplococcus."

The latest and most authoritative utterances on the subject, however, declare that the bacillus shows a marked *tendency* to bipolar staining and this characteristic is a prominent diagnostic feature, but not by any means the only one. In fact, Tidswell, of Sydney, after a most elaborate and exhaustive study of 303 cases in the recent epidemic in that city finds that while it is not uncommon to find individual elements taking the stain only in a narrow band at each end, there are others which stain uniformly throughout the entire length, but that by far the great majority occupy a mean distance between these two extremes, namely, full stain at the poles, light or absent in the center. This is the true import of the so-called bipolar staining. Other characteristics of the bacillus, besides that of its peculiar staining, are of the utmost importance upon a closer acquaintance; its varying length, its uniform breadth, the shape of its ends, its cultural behavior in the growth and form of its colonies, its possible involution forms, and other important features, all of the greatest interest and value; but to have a theoretical mental picture of a plague bacillus and expect every element to conform to it in size, shape, and stain will be as disappointing as to expect every leaf on a given tree to be precisely the same shape and tinge or to expect in each individual in a basket of any given fruit, the same unvarying size and shape.

In our series of 4 cases I have been most fortunate in obtaining in each case direct from glands and spleen, cover slip smear preparations teeming with bacilli which showed their distinctive characteristics at first glance; but it is to be remembered that each of the 4 cases in its clinical aspects was well developed, marked, and typical. In an epidemic, this is not always the case—as for instance, the San Francisco federal commission state in their admirable report as published by the U. S. Marine-Hospital Service (PUBLIC HEALTH REPORTS, pp. 801 and 816 inclusive), that they found a little Chinese girl dead at No. 747 Sacramento street, in whom "no external signs of plague were visible," yet the bacillus was demonstrated in her spleen, and from this organ a guinea pig was inoculated and died in four and a half days with plague, the viscera showing "enormous numbers" of the bacilli. The well-marked and typical cases present no great diagnostic difficulties either to the clinician or to the bacteriologist. It is the

constant possibility' of the more obscure and masked cases which demand the constant unremitting vigilance of both observers.

The following notes are furnished in addition to the usual reports made upon each and every post-mortem examination at the governmental morgue :

*Case 1.*—During the forenoon of May 30, I accompanied Dr. Pratt to the bedside of Man Sing, on Hustace street, and with a sterilized instrument, aspirated a large bubo found in the right inguino femoral region, with the point of the needle well within the substance of a greatly inflamed and swollen gland, succeeded in withdrawing a few drops of blood-stained serum from which several cover slip smears were prepared and implantations made upon slants of nutrient agar-agar and coagulated blood serum, which were placed in the incubator at 37° C. An immediate examination of the smears showed great numbers of the *B. pestis*. Immediately after the necropsy, at 5 p. m. on the following day, additional smears were made from glands and spleen and additional tubes planted and placed in the incubator at body temperature. All of the tubes followed the regular typical routine, showing in the course of a few days the usual colonies of plague bacilli in every tube, while in some of them there also developed colonies of the usual pyogenic bacteria, chiefly the staphylococcus pyogenes.

*Case 2.*—Ah Loy ; necropsy performed at 10.30 a. m., June 4, and immediately thereafter smears were made from glands and spleen and some half dozen tubes planted and placed in the incubator. The smears all confirmed the clinical suspicion of plague, the bacilli being present in large numbers.

*Case 3.*—Gosoburo Mazuki ; necropsy at 3 p. m., June 6, smears from glands and spleen all contain *B. pestis* ; tubes planted from glands and spleen.

*Case 4.*—Gang Moon ; necropsy at 11.45 p. m., June 10, followed at once by preparation of smears and planting of tubes, the latter being immediately placed in the incubator. The smears on examination all showed large numbers of the *B. pestis*.

Although in every case a clear diagnosis was established direct from the tissues, it was deemed advisable to supplement the findings with animal inoculations, a measure indispensable and imperative where any doubt exists as to the nature of the disease or the character of the bacteria found.

Laboratory rat No. 5 : Was hypodermatically injected on June 5 in the sacral region with 1 cubic centimeter of sterilized water rendered turbid by addition from a five days' growth on agar, implanted from the spleen of Man Sing. On the following day he began to show signs of indisposition, and for two or three days thereafter seemed very ill as shown by his ruffled coat, inactivity, loss of appetite, etc., with evidently a high fever, as he drank an inordinate amount of water. By the fourth day he seemed brighter and more sprightly, continuing to improve until he was completely recovered. A subsequent examination of the colonies used in the inoculation would seem to indicate that he may have received a larger proportion of staphylococci than of *B. pestis*.

Laboratory rat No. 6 : Was injected subcutaneously at 10 p. m., June 6, with 1 c. c. of blood-stained "juice" from the spleen of Ah Loy. He was found very ill the following morning, his symptoms increasing in intensity until he passed into a semicomatose condition and died thirty-eight hours from the time of inoculation. The necropsy showed a right conglomerate inguinal gland enlarged to the size of an average lima bean and a left axillary gland of about half the size of the former, both

surrounded by tissues infiltrated with serous exudate; the heart, lungs, liver, kidneys, and spleen intensely congested; liver large and mottled with areas of gray to slate color; spleen reddish black and enlarged in all dimensions; mesenteric glands enlarged; no fluid in peritoneal cavity. Smears from gland and spleen all show enormous numbers of *B. pestis*.

Laboratory rat No. 7: Was injected hypodermatically at 3 p. m., June 15, with a c. c. of sterilized water in which had been macerated and triturated the spleen of a dead plague rat found in the vicinity of Beretania and Nuuanu streets. After passing through the various stages of indisposition and severe illness observed in the others, he was found dead on the morning of June 18. Necropsy showed right inguinal gland enlarged to 1.5 cm. long, 8 mm. wide, 5 mm. thick, surrounded by serous infiltration; spleen normal size, but almost black in color; all other organs moderately congested; liver slightly mottled. Smears were made from inguinal gland, spleen, kidney, liver, lung, and heart blood. The *B. pestis* was found, though few in number, in all, except kidney and lung, where it seemed to be entirely absent.

Suspicion having attached to the finding of an occasional dead rat in various localities, examinations were made upon a few sent to the laboratory, as follows:

Dead rat No. 1: Found in the vicinity of Nuuanu and Beretania streets; necropsy June 14. Inguinal glands on both sides very slightly enlarged; no axillary glands palpable; liver, large, mottled, congested; spleen congested; kidneys very dark red. Cover-slip smears from spleen show the *B. pestis* in large numbers, those from the inguinal glands, very few. Tubes planted from spleen—also laboratory rat No. 7 inoculated from spleen.

Dead rat No. 2: Found at Iwilei; necropsy, June 15; both inguinal and left axillary glands enlarged; liver, normal size and mottled; kidneys, rather pale; spleen, unusually large and congested. Gland and spleen smears show *B. pestis*.

Dead rat No. 3: Found near Nuuanu and Beretania streets; necropsy June 17; both inguinal glands slightly enlarged; spleen unusually large and thick, and reddish black in color; all other organs moderately congested. Spleen smears show *B. pestis* plentiful in spleen, very few in gland.

Dead rat No. 4: Found at fertilizer works, Kewalo; necropsy June 18. Glands normal size; spleen rather large and congested; all other viscera look normal except liver, which is slightly enlarged and contains externally a single small spot of a grayish color. Microscopical examination of smears from this rat were entirely negative as regards *B. pestis*.

Dead rat No. 5: Found near Chaplain lane; necropsy on June 18; no enlarged inguinal glands; spleen large and very dark color; all other organs rather pale. Smears from spleen negative as regards *B. pestis*.

Dead rat No. 6: This rat was caught in a trap, King street near river; large, well-developed male; seems perfectly healthy; chloroformed to death and necropsy made June 18; a right axillary gland thought to be slightly enlarged; spleen small, narrow, of a delicate pinkish red; lungs pinkish white; all viscera considered normal and healthy. Microscopical examination of smears entirely negative and sterile.

Dead rat No. 7: Found on Vineyard street near Nuuanu; necropsy, June 20, small size; no inguinal or axillary glands palpable; lungs, spotted with areas of congestion; heart, very dark red; liver, large, no mottling, and of normal color; spleen, unusually small and thin, but of

very dark color, nearly black. Smears from spleen show the *B. pestis*. While a few are typical most of them are unusually long, with frequently two joined together end to end.

Dead rat No. 8: This animal was a mouse, but is called "Rat No. 8," to include it in the series. Found in the neighborhood of Honolulu stock yards; necropsy, June 20. All viscera deemed about normal; spleen very small and of light pinkish red color. Spleen smears negative as regards *B. pestis*.

Dead rat No. 9: Also a mouse, found at Kewale government stables; necropsy, June 21; liver, mottled from grayish slate color to black; all other viscera congested, except spleen, which was very thin and small and red in color. Smears from spleen showed *B. pestis* certainly present, but very few in number.

Dead rat No. 10: Found dead in a trap, Nuuanu street near Judd, and accompanied by a live one; necropsy June 26. Under sized; has a lacerated wound in right epigastrium; thought to have been attacked and killed by his companion; all viscera seen, normal; spleen, pinkish red, small, and thin; no enlarged glands. Spleen smears negative, as regards *B. pestis*.

Dead rat No. 11: The companion of the above, a large, well-developed, healthy looking male, savage and vicious; killed by potassium cyanide; necropsy June 26. No enlarged lymphatics; liver, spleen, and kidneys deeply congested, with first two organs unusually large. Spleen smears negative in regard to *B. pestis*.

In regard to results obtained from implantations upon slants of the various culture media, without entering into repetition and uninteresting detail, it may suffice to say, that all tubes, with one or two exceptions of No. 2's, developed vigorous growths of colonies of *B. pestis*, but in several instances there were also found extensive colonies of pyogenic bacteria, a circumstance to be expected, as experienced in every epidemic of plague.

In concluding this report, it may be of interest to summarize what seems to me to be the latest and most authoritative facts and opinions deduced from the bacteriology of plague, gathered from various sources and from different parts of the world. It is true that on many points of lesser importance authorities still differ, and that there is yet much to learn concerning the disease, but the following, so far as it goes, may fairly be taken as a consensus of opinion among the leading investigators.

1. The bacillus of plague, outside of the animal body, is easily killed. Direct sunlight destroys its vitality in three to four hours. Thorough drying kills it in four days, and the temperature of boiling water in a few minutes. It is destroyed at once by a solution of corrosive sublimate of the strength of one to a thousand. A 1 per cent solution of carbolic acid or the same strength of lysol kills it in ten minutes. In ordinary tap water the bacilli die in three days and in sterilized water in eight days.

2. It can not enter the human body through the unbroken skin. It is not conveyed alive in the air in dust, as is the bacillus of tuberculosis. It enters the body either through slight wounds and scratches or through the medium of contaminated food or drink.

3. Bubonic plague is par excellence a filth disease. It thrives in dark, damp, and unsanitary surroundings, and the means for its extermination lie along the lines of good sewerage, healthful environment, with wholesome and cleanly living.

4. It kills by the deadly toxins, elaborated by the bacteria over-

whelming the vital powers, and for the successful treatment of which a satisfactory remedy is not yet discovered.

Respectfully,

J. T. McDONALD.  
*Bacteriologist.*

C. B. COOPER, M. D.,  
*President Board of Health, Hawaii.*

*Supplementary report—Dr. J. T. McDonald, bacteriologist.*

HONOLULU, H. I., September 4, 1901.

SIR: Since my last special report to the board on 4 cases of bubonic plague occurring in Honolulu, I have made 3 additional suspicious necropsies, and the following notes embody the bacteriological findings in connection therewith. They are to be regarded as supplementary to my post-mortem reports on the several cases already on file.

*John Ili.*—On June 25 at 2 p. m., at the morgue, I performed a necropsy on the body of John Ili, at the close of which I dissected out from the right inguinal region a firm conglomerate gland 2 by 3 by 1½ inches in size which I found surrounded by a large area of bloody serous infiltration. From a section through the center of the mass I made a number of cover-slip smears. I also made several from a section of the spleen, using instruments previously sterilized for the purpose. All these were stained with dilute Ziehl's carbol-fuchsin, which in my hands has proved more satisfactory than any other. Every one, without exception, showed the presence of the bacillus pestis, in numbers not so large as in some other cases, but amply sufficient, together with their morphology, etc., to establish their identity beyond the shadow of a doubt.

Laboratory rat No. 8: Was injected in the sacral region with half a cubic centimeter of bloody serum from the gland and its surrounding tissues.

*Souichi Ogawa.*—On July 5, at 9 a. m., I aspirated a left inguino-femoral bubo of Souichi Ogawa in his room, Hotel and Kekaulike streets, obtaining a few drops of blood-stained serum which I examined within half an hour, and found the bacillus pestis in large numbers. The patient died at 9 p. m., on the evening of the following day, and I performed a necropsy on his body at the morgue at 11 p. m. The bubo was dissected out; smears were made from a section in the interior of the inflamed gland, and also from the spleen. While all showed the *B. pestis*, those from the spleen in this case were more abundant. All were characteristic and typical.

Laboratory rat No. 9: Was injected in the sacral region with "juice" from the bottom of a beaker containing the gland and a piece of spleen.

*John Pio.*—At 5 p. m. on July 17 I aspirated a large bubo in the left inguino-femoral region of John Pio at his residence on Queen street near South and obtained a few drops of blood-stained serum from which smears were prepared at once and examined, all showing the *B. pestis*, but rather few in number. He died four hours later and the necropsy was made at 11.45 p. m. Smears from the spleen contained rather few of the *B. pestis*, but those from the gland section showed the bacilli in enormous numbers. Comparing the latter slides with those made from the aspirated serum, it would seem that the point of the needle had not properly entered a gland during aspiration, which was done under somewhat unfavorable conditions, the patient being wildly delirious and in constant motion. All slides from the gland of this patient were